TOPICAL OUTLINE

VIRGINIA GIS REFERENCE BOOK

General Application Name: Finance/Tax – parcel mapping

Product/Service/Function Name: Archive of Parcel Changes

P/S/F Description:

Across the Commonwealth and throughout the U.S., many localities are facing the increased demands from population growth on property ownership management, land use management, and resource management. To address these issues adequately, there is a basic need to collect, maintain, analyze, and distribute digital geographic data representing parcel mapping and other related information. The main elements of parcel mapping include land ownership information and a system or archive of parcel changes. Much of the information supporting parcel related decisions in localities are derived from the present and historical records of parcel mapping. To maintain a historical record of parcel mapping, localities can use an archive of parcel changes. This type of historical information tracking is a snap shot of the entire parcel mapping at a point in time. Localities may use this information to evaluate land succession, historical land use changes, historical land ownership trends, and tax assessment patterns over time.

Product/Service/Function_____

1. Spatial Data – Minimum Requirements – Optional Requirements

   Spatial data refer to any type of data that represents specific features on the earth in defined geographic areas. Spatial data for archive of parcel changes is comprised of a historical record of the geographic location of property boundaries over time. Traditionally, planning departments have been responsible for the development and maintenance of paper (hardcopy) parcel tax maps or real estate maps that depict parcel boundaries as lines on a map. Unfortunately, parcel maps are outdated as soon as they are collected due to changes from real estate transactions such as new subdivision. To account for this, planning departments sometimes store copies of paper tax maps or digital tax maps for many different years or decades. These copies often are periodic snap shots, such as yearly views of parcel information as it existed at that time that record changes in ownership and geometry.

   

   Scanned historic parcel map

   Minimum Requirements
   The minimum requirements for the spatial data include creating digital images of the historical paper parcel maps by scanning these maps using a scanning machine. Digital images are referred to as raster data, and can be

created in various image formats such as JPEG or TIFF. These formats are regularly used to develop computer images.

Optional requirements
Once a locality has a digital parcel map in a GIS representing all its current tax maps, then the locality can begin to maintain an archive of parcel changes on a yearly basis. This type of historical parcel tracking involves storing a copy or archive of the entire GIS database each year. Local governments often do this once each year to document and archive the tax parcel mapping, as it exists at the end of the tax assessment cycle. Over time these yearly archives can be analyzed for changes in assessment patterns and can be used to document the state of the taxable base at a point in time. Normally this type of archival system does not monitor intermediate changes that occur between archive periods. At a minimum, the hardcopy tax maps for a municipality should be converted into a standard format compliant with one of the major GIS software platforms. Individual property boundaries should be stored as line and area features in the GIS, and archived on a yearly basis in separate databases.

In recent years, certain GIS vendors have released GIS software with the functionality to edit and store alternate versions and history of GIS data in the same commercial database. Basically, a locality could implement this cutting edge technology and create a database that stores as many digital versions of tax map data as required by the locality, all in the same database and accessible through the GIS software. This new software would allow a locality to create and maintain an archive of parcel changes automatically each year and manage this data seamlessly within the same database.

2. Attribute Data – Minimum Requirements – Optional Requirements

Attribute data refers to descriptive information associated with geographic features or spatial data (i.e., streets, rivers, or parcel boundaries). This data is normally stored as fields in a database or spreadsheet, then entered into the GIS and stored in attribute fields linked to the spatial data.

Minimum Requirements
In order to link the spatial data (i.e., parcel features) in a GIS with the land ownership attribute information stored in the tax assessment database, each GIS parcel feature should contain a unique parcel identification number in its attribute table that matches parcel identification numbers or property tax number in the tax assessment database. When this is accomplished, tax assessment databases can be digitally linked to the GIS parcel features.

Optional requirements
Using the scanned parcel map images and existing tax assessment database information, additional attributes can be collected and added to the attribute table for each parcel in the GIS:

- Address
- Dimensions
- Subdivision Names
- Plat Names
- Right of Ways
- Geographic Parcel Identification Number (GPIN)

A GPIN is a relatively new methodology for creating unique parcel identification numbers based on spatial X Y coordinates as opposed to older methods of creating property tax numbers that are based on the tax map, block, and lot numbers. GPIN methodology has been used in other Virginia municipalities including the city of Richmond and City of Suffolk.

3. Data Acquisition Options (integrated with VBMP digital orthos)

   Many parcel tax applications require a means to retrieve historical versions of tax information. The historical parcel mapping provide a graphic representation of past assessment rolls, assist assessors and planners with making value determinations on new parcels, and support many other analysis functions. Managing historical parcel information is an important part of any parcel mapping system.

   Data acquisition for archiving parcel mapping involves:
   1. Digitization of property boundary features based on parcel maps, then archiving digital parcel data every year
   2. Scanning historic paper parcel maps (if available) to create digital images.
   3. Maintaining multiple or alternate yearly version of the digital parcel maps stored in the same database using new GIS technology

   A locality essentially has three options for developing and maintaining an archive of parcel changes. First, a locality can scan all existing paper tax maps. In addition, a locality can enact a policy to print paper copies of its digital parcel map from the GIS at the end of each year, then scan these copies into digital images and maintain these archives of parcel changes from year to year. As a result, a locality will have a record of the existing condition of its parcel mapping for each year even though changes are made to the digital parcel map in the GIS. It is recommended that a locality utilize specialized image compression software to minimize the storage size of all digital images created. The second option for a locality is to store a copy of the digital parcel map for each year as a separate database in the GIS, thereby creating a digital archive of parcel changes. The final option is to employ new GIS software to create alternate, transactional versions of the parcel maps in the same commercial database.

4. Data Conflation Options (integrated with VBMP digital orthos)

   Data conflation is the process of updating parcel data in a GIS to match the most accurate data sources. If a locality plans on performing this task in-house, it is imperative for the locality to have the necessary source data. Two options exist for data conflation depending on the type of data stored in the archive of parcel changes.

   1. If a locality intends to maintain an archive of parcel changes with digitally scanned parcel maps then the images should be georeferenced or matched to the proper location on the existing orthophotography. As best as possible, points found on the parcel map image (primarily road intersections and other identifiable features) will be tied to the same points found on the orthophotography. In this fashion, each parcel map image will be "warped" to fit the orthophotography. It must be noted that because historic parcel maps will be of lower accuracy than orthophotography, it will not be possible to make a perfect fit.

   2. If a locality plans to maintain an archive of parcel changes by storing a copy of the digital parcel map each year, then property boundary line locations can be conflated or matched to actual ground and cultural features visible in the digital orthophotography (i.e., VBMP digital orthos). By conflating GIS parcel features with digital orthophotography, a municipality can ensure the digital parcel map conforms to the best spatial source.

5. GUI/Programming Options

A GUI means Graphical User Interface. A GUI is the graphics a computer user sees on the computer screen when they run a computer program. For example, when a user runs the program Microsoft Word, the familiar white screen pops up with various toolbars and buttons at the top. This can be considered a GUI. Depending on the GIS software platform used to create and maintain an archive of parcel information, a municipality has the ability to develop customized programs that alter the look of the GUI and streamline certain processes. A municipality can develop programs that run within the main graphical window of the GIS software. An example of this would be the development of a program to allow users to simply press a button to see the results of a query on a map that retrieves historic parcel information from a database of parcel archives.

6. Internet Functionality and Options

   The internet offers an excellent medium for distributing data and information in a public domain. By utilizing the internet, a municipality could develop a mapping website that displays the entire current digital parcel map for the municipality and be accessed by any user with a computer and an internet connection. In this website, historical parcel information could be illustrated along with data showing development trends in high priority sections of a locality such as coastal areas. In providing parcel information over the internet, a locality can better serve its citizens and keep them up-to-date with current and past changes affecting the locality.

7. Minimum Technical Requirements – Optimum Technical Requirements

   The following minimum technical requirements apply to the hardware/software configurement recommended to implement and maintain parcel mapping in a GIS.

   Hardware
   - IBM PC or compatible computer
   - Windows NT service pack 6a, Windows 2000 service pack 2, Windows XP Home Edition, or Windows XP Professional Edition
   - PC with a fast Pentium chip (450 Mhz minimum)
   - 128MB RAM minimum
   - 10 GB hard drive
   - Fast disks (SCSI as opposed to IDE)
   - True color monitor with a minimum of 16MB video card
   - Paging File (Swap Space) at a minimum of 300MB.

   Software
   - Windows, Macintosh, or Unix compatible
   - From any leading GIS software vendor (i.e., ESRI, Intergraph, Autodesk)

The following optimum technical requirements apply to the hardware/software configurement recommended to implement and maintain parcel mapping in a GIS.

   Hardware
   - Windows NT service pack 6a or Windows 2000 service pack 2
   - PC with a fast Pentium chip (750Mhz or higher recommended)
   - 256MB RAM or above
   - 20 – 40 GB hard drive
   - Fast disks (SCSI as opposed to IDE)
   - True color monitor with a minimum of 32 MB video card

- Paging File (Swap Space) at a minimum of 300MB.

Software
- Windows compatible
- ESRI GIS software packages (consistent with other localities in Virginia)
- Specialized parcel editing software from ESRI business partners NovaLIS or SDS
- Specialized image compression software
- Commercial databases (IBM DB2, Informix, Microsoft SQL Server, and Oracle)

8. Administrative/Management Requirements

Several issues must be addressed when determining the management requirements for archiving parcel change information in a GIS. Initially, a locality must decide whether to develop and maintain the data by hiring a consultant or with in-house staff. This decision will depend on factors such as budgetary issues, staff expertise, staff availability, scheduling, and technical resources of the locality. If a locality decides to internally create and maintain parcel archive data in a GIS, then personnel must be identified for the project. Conducting a strategic plan up-front will allow a locality to identify current staff that may aid in the development of the GIS. A locality should start by selecting staff members with an interest and background in geography, mapping, computers, or engineering. Personnel with this kind of experience usually understand the basic concepts behind mapping spatial data and will probably learn GIS much faster than other employees. Personnel from the assessor and/or planning departments are ideal candidates for GIS training.

Several types of staff will be needed to develop GIS data and maintain the system. First, a qualified manager with experience working with spatial data should be assigned to oversee the development of a municipality's spatial data and guide the policies governing the use of this data. For a locality in the early stages of GIS development and with little GIS expertise, this means hiring a GIS manager from external sources. Second, selected staff members from the departments identified above should be trained to complete tasks commonly performed in a GIS. This includes scanning historic tax maps, creating digital images, georeferencing the images to orthophotography, creating archives of parcel changes each year, and creating map products for local planning and reporting purposes. Overall, a locality will need one GIS manager and 1-2 staff members dedicated this effort depending on the density of the current and historic parcel maps.

It is vitally important to establish administrative procedures governing the development, use, and distribution of parcel mapping data. The administrative requirements regarding the data collection, management, and access of parcel mapping data must also include policies covering data privacy issues, liability for GIS data, and possible copyright protection.

9. Cost – Cost/Benefit

In many cases, it may be easier and more efficient for a locality to evaluate and lump the costs and benefits of archiving parcel changes with the costs and benefits of developing land ownership identification data. The methods for data acquisition and data conflation for these two sub-applications are very similar. As stated in the discussion concerning land ownership identification, the costs associated with developing a parcel data can widely vary depending on the spatial needs of a municipality. It is always important to investigate the "bottom line" costs of implementing a GIS to determine the financial justification for such an endeavor, and to estimate the adequate level of funding required to develop and implement a GIS. Costs related to archiving parcel mapping changes can be separated into two phases:

- Implementation Costs
- Operational Costs

Implementation costs can include hardware/software acquisition, consulting services, and data development. Start-up costs for a locality involve investing in the necessary hardware and software. Hardware costs include a dedicated computer server for the GIS and PC's for the staff assigned to work on the GIS. Suitable computer servers can range in cost from $10,000 - $50,000, depending on the technical specifications like processor speed and memory. PC's that meet the minimum technical requirements to operate GIS software range in cost from $800 - $2000. GIS software costs will vary depending on the software package purchased. Current prices (per copy of software) for GIS software are $1000 - $1500 for low-end products, $4000- $5000 for middle-end products, and $10,000 - $12,000 for high-end products. The costs associated with data development (i.e., scanning historic parcel maps) will vary depending on the user requirements and scanning methodology used, but estimates generally range between $4 -$6 per parcel map for a black/white image and $4-$5 per square foot of parcel map for a color image. The total cost to create digital images of historic paper parcel maps generally runs between $1000 - $5000. It is important to note these costs vary based on the number of the paper parcel maps. In addition, there are costs associated with storing archives of the parcel changes for digitized parcel boundaries each year.

Provided below is a summary of the costs for tasks required to develop an archive of parcel changes, using a consultant:

***Needs Analysis** – Needs Assessment; Data Survey; Management Plan; System Implementation Plan	$25,000 - $50,000
***System Design** – Aerial Photography Specifications; Database Design; Hardware/Software Selection; Software Specifications	$20,000 - $100,000
***Hardware** – 1 Servers and 2 Workstations	$10,000 - $15,000
***Software** –GIS Software	$10,000 - $50,000
***Peripherals** – Plotters; Printers; Scanners; Digitizers; GPS Equipment	$20,000 - $50,000
***Staffing (Annual)** – GIS Manager; Analysts; Technicians; Programmers	$80,000 - $200,000
***Training**	$10,000 - $40,000
Parcel Map Scanning - Archive Development	$1000 - $10,000
Application Development	$5000 - $50,000
Future Consulting	$10,000 - $500,000

*Note: Denotes a task to be performed in conjunction with the land ownership identification sub-application, and therefore a shared cost.

After the implementation is complete, a municipality must enact operational procedures to ensure the currency of the parcel mapping data is protected through yearly maintenance of parcel archive information in the GIS. Operational costs associated with data maintenance will simply be the amount of staff time dedicated to this effort. A locality should have at least 2 staff members (1 GIS Manager, 1 technician) working full-time on the GIS, so the costs would be the salaries of these staff members.

Quantifying the major GIS benefits is very difficult, but there are some benchmark studies that documented productivity improvements and cost savings produced by GIS. One of the studies most referenced for cost and benefit data related to GIS is the *Joint Nordic Project – Community Benefit of Digital Spatial Information* cited in *The GIS Book (George B. Korte, 1997)*. This study collected

information on the costs and benefits of 16 GIS projects. The following findings offer general estimate ratios for benefit/cost (B:C) returns:

- GIS is used only for digital mapping of land ownership information – **1:1** return
- GIS used for planning and engineering tasks – **2:1** return
- All paper parcel maps converted to digital maps – **3:1** return
- GIS is used to create and maintain all spatial data – **4:1** return
- GIS data stored in one database and shared by all user departments – **4:1** return
- An automated system in GIS for localities with poor quality parcel maps and maintenance procedures – **7:1** return

10. Standards/Guidelines Summary

Standard processes for archives of parcel changes will certainly depend on the locality of interest. There really is no common standard for developing and maintaining this data. Some localities may keep the most current representation of parcels on paper maps and in their GIS and not be concerned with past representations. Others may keep periodic copies, such as monthly, quarterly, or yearly views of parcel maps as it existed at that time. Still others may track changes on a daily basis and maintain a record of all changes in parcel mapping. In general, the majority of localities archive parcel changes once each year to document the tax roll as it exists at the end of the tax or assessment cycle.

In Virginia, many localities have digitized their current paper parcel maps and conflated this data to digital orthophotography. Some have also created digital images of their historical parcel maps and archived this data. In essence, the data is only as accurate as the source it came from which is the paper tax maps. The majority of municipal paper tax maps are developed at scales between 1 inch = 200 feet and 1 inch = 400 feet. Digital parcel maps based on these sources will only be as accurate as the National Map Accuracy Standards (NMAS) for data sources at these scales, but caution must be heeded because accuracy may be degraded further by the poor quality of the hardcopy parcel maps. There are no pre-defined accuracy requirements for GIS parcel data, so accuracy specifications usually depends on a municipality's requirements and day-to-day information needs. It is recommended that a municipality utilize digital orthophotography as a base map and a source for geo-referencing scanned tax maps. In the State of Virginia, many municipalities geo-reference their GIS data in the Virginia State Plane coordinate system (NAD 1983).

11. Startup Procedures/Steps

Building a successful GIS database of archived parcel changes should consist of several startup procedures including planning the project, communicating the project plan to all interested parties, gathering data sources and resources, setting achievable milestones, and gaining manager support. The up-front planning of this effort must accomplish the following:

- Establish goals and strategies
- Perform a needs assessment with end users in the planning and assessor departments
- Determine data requirements based on the needs analysis
- Prepare a budget and project timeline
- Determine if a consultant or in-house labor will perform the work

Once again, these steps should be accomplished as part of a larger effort that includes the land ownership identification sub-application. Based on the cost estimates for outsourcing the GIS work to a consultant, the in-house staff, and GIS budget, a locality must determine whether to perform the

work internally or have a consultant complete the work. Once this decision is made, a locality must invest in the hardware and software needed to run the GIS. The number of computers and number of software packages to purchase should be specified in a needs analysis.

12. Estimated time line and/or implementation (stand alone) schedule

    Estimating the time line or schedule of an archive of parcel changes project will certainly depend on a number of factors specific to a municipality, including:

    - Number of historic parcels maps covering the municipality
    - Staff expertise performing the work
    - Personnel dedicated to the project
    - Funding

    For most localities, a reasonable estimation for the timeline to create an archive of digital images representing historic parcel maps is 1-2 months.

13. Best Practice Examples in Virginia

    Several municipalities a have completed parcel mapping projects that involve the conversion of hardcopy parcel maps to vector GIS formats and digital images, use digital orthophotography for referencing, and integrate land ownership identification information with the GIS. Notable examples include the City of Richmond digital parcel map (complete), which can be viewed on-line at http://www.ci.richmond.va.us/department/gis/index.asp. Due to the large size of many historic parcel maps, a locality may have contract with a consultant or professional imaging service to have the maps scanned into digital format. Professional imaging services have the necessary equipment to scan oversized parcel maps into digital formats compatible with GIS software.

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